

Baylor College of Medicine's Center for Health Ethics and Policy in Houston (TX, USA), and Carl Barrett, former head of the EGP, now at the US National Cancer Institute (Bethesda, MD, USA). They noted that the project presents unique and unprecedented challenges, perhaps most important of which is the question of personal responsibility. If certain polymorphisms are known to confer greater susceptibility to and higher risk of disease, the choice of lifestyle and occupation becomes increasingly important not only for the individual, but also for society, as it eventually has to pay the medical bill. Will society test its citizens for genetic susceptibilities and keep track of lifestyle and occupation, or will it allow its citizens free choice, even in the light of known health risks?

But, first and foremost, it is important to educate people so that they are able to understand the implications and are eventually prepared to make such choices. Paul Spicer, of the University of Colorado's Health Sciences Center (Denver, CO, USA), is working with Native Americans, with whom genetic research has long been fraught with difficulties, due to their beliefs about the sanctity of the body and an understandable fear of exploitation. Spicer started his project by articulating the problems and possibilities arising from genetic knowledge about the population, and, by consulting members of urban and rural Native American communities, he hopes to formulate guidelines with which to conduct research and deliver genetic health services in these communities. His work is equally important for forging partnerships between inner-city, minority and rural populations, and local universities and community health institutions. These studies should eventually benefit everyone—and especially communities in locations that bear a disproportionate burden of environmental pollution. As the EGP's work and other research in the area of molecular medicine is providing more information, such partnerships may even become important in helping to educate people about the significance of their genetic makeup and to deal with potential problems, such as workplace discrimination or insurance bias.

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# Science and sustainability

**More research is paramount for finding sustainable solutions for agriculture in developing countries. But politics has an equally important role**

At the 1992 Earth Summit in Rio de Janeiro, Brazil, sustainable development emerged as a new paradigm for integrating economic growth, social development and environmental protection. Last year, the United Nations World Summit in Johannesburg, South Africa, once again brought this topic to the world's attention by reviewing the Rio agenda and proposing further implementation of sustainable development worldwide. The United Nations Secretary General, Kofi Annan, identified five main topics—water, energy, health, agriculture and biodiversity—that need to be tackled to preserve the planet's natural resources for the coming generations, and to improve the quality of life for the current human population.

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But, first and foremost, agricultural production needs to increase to produce sufficient food for the human population without further destroying already dwindling ecosystems and biodiversity. This problem was the special focus of the meeting entitled 'The contribution of life sciences and biotechnology towards sustainable agriculture for developing countries' that the European Union (EU) organized in Brussels in January this year. The participants at the two-day meeting discussed the progress already made in developing countries, and how this can be improved further through scientific advances and by applying new technologies.

The challenge facing agriculture is massive and well documented. It is clear that current methods of food production, in both the developing as well as the developed world, are neither sufficient nor sustainable.

More than 800 million people are chronically undernourished, and to meet the demands of a burgeoning human population, which is expected to hit the 8 billion mark in 2025, grain production will have to increase by 40%. Equally worrying, more than 10% of the world's current agricultural activities are based on unsustainable water resources. Overuse and over-irrigation are leading to further desertification and loss of arable land, with the result that many areas can no longer sustain any form of agriculture. At present, 11% of the world's land surface is used in crop production, and any increase in this activity in Africa, Asia and Latin America poses a grave threat to worldwide biodiversity. Industrialized agriculture in the developed world is equally as far from being sustainable, with its heavy reliance on fertilizers, pesticides and herbicides that create environmental problems and cause further loss of biodiversity. Philippe Busquin, the European Commissioner for Research, emphasized at the Brussels meeting that there is an immediate need to find scientific solutions to secure sustainable agriculture in the future. Ismael Serageldin, now the Director of the Biblioteca Alexandrina, Egypt, and former Vice President of the World Bank, also underlined the role of research in sustainable agriculture, pointing out that high-yield crops have helped to reduce the amount of land used for cultivation by 300 million hectares each year, an area equivalent to those of the USA, Canada and Brazil combined. But he stressed that the advances made through biotechnology have so far made an impact mainly on industrialized countries, and have had only a marginal effect on developing countries.

A general definition of 'sustainable', in agricultural terms, would be an adequate level of high-quality food production in the countries that are, at present, unable to feed their own populations. In many African countries, the producers and the consumers are often the same people, and any advance towards such a goal would

therefore have to be achieved through local structures, said Florence Wambugu, Executive Director of the Harvest Biotech Foundation, a non-profit organization committed to sustainable agriculture through the use of biotechnology. She concluded that new technologies should be accessible to farmers, who can then adapt them to local conditions. This, however, implies that production and distribution are supported by a stable social and political infrastructure, something that many African countries are clearly lacking.

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Encouragingly, the meeting provided ample evidence of how scientists in developing countries are producing specific solutions to local problems. Luis Estrella-Herrera, from the Plant Genetic Engineering Department at the Irapuato National Polytechnic Institute in Mexico, described how biotechnology could help to increase food production from Mexico's poor-quality soils, in which the high concentration of aluminium ions cause a decline of up to 80% in plant productivity. By genetically modifying the metabolism of maize plants, his research team have developed a plant line that releases citric acid into the soil to sequester the aluminium. A combination of agronomic strategies, such as lime application, together with these genetically modified (GM) plants resulted in dramatically improved productivity.

Indeed, any progress towards sustainable development will have to include GM technologies, thinks Jim Peacock from CSIRO Plant Industry in Canberra, Australia. Through the use of transgenic pest-resistant cotton crops, he showed that a 60% reduction in the use of pesticides could be achieved. This has helped to protect local biodiversity, particularly beneficial insects that were then able to fight off parasitic insect pests. Furthermore, insect resistance to the GM plants was kept low by growing non-GM cotton nearby.

Biodiversity in relation to African cattle was discussed by Olivier Hanotte, project leader at the International Livestock Research Institute in Nairobi, Kenya. Cattle diseases are a major problem, particularly for developing

countries, but livestock have developed their own resistance mechanisms against infectious agents. The task now is to understand how these mechanisms work. Trypanosomes, for example, threaten 60 million cattle per year, as well as humans, in the endemic areas, and there is, at present, no effective method to fight this disease. However, African N'Dama cattle have evolved a set of genes that make them resistant to trypanosomes, so interbreeding between susceptible cattle and N'Damas could produce new lines with a higher tolerance to these parasites. Such attempts have so far been unsuccessful, but Hanotte stressed that preserving existing diversity, such as the N'Dama cattle, may nevertheless help in the development of new solutions for the future. Similarly, Tilahun Yilma, Director of the International Laboratory of Molecular Biology for Tropical Disease Agents at the University of California, Davis (CA, USA), discussed developments in controlling rinderpest, a fatal cattle disease that leads to death. Scientists at his institute have developed an ELISA-based test to distinguish between vaccinated and rinderpest-infected animals in the areas of Africa and Asia where the disease is endemic.

But the meeting was not just about science. A good part of the two days was devoted to critically examining and discussing future policies in both developed and developing countries. Paulo Arruda, Professor of Genetics at the University of Campinas in Brazil, and co-founder of

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Alellyx, a biotech company in Campinas, presented Brazil's experience in developing its own research base. Since the Brazilian government decided to support biological research, it has stood by its decision, while at the same time it has restructured the country's educational system. The government funded young students to study abroad, but also created the infrastructure to lure them back; and now, Arruda claimed, Brazil can be proud of the scientific progress made by its own researchers.

This can also be said of China, a country that is now making great leaps forward in the biosciences, according to Juanming Yang from the Beijing Genomics Institute. China morphed, within a couple of years, from being a developing country to becoming a contributor to the Human Genome Project that accomplished its allotted 1% of the human genome in only eight months. Indeed, the Chinese government has made considerable investments into research infrastructure, reforming its education system and attracting Chinese scientists back from Europe and the USA. It is an impressive performance indeed, and Yang ended his talk with the question "If even China can do it, why can't you?" However, whereas the Brazilian success story was all about a step-by-step progression, China gave the impression that it had accomplished a remarkable about-turn overnight. But this was, in fact, with the help of the industrialized world, which was intrigued by the potentially huge market of mainland China; the Wellcome Trust donated up-to-date instruments to Beijing, and GlaxoSmithKline provided funding for the instruments at the Shanghai National Human Genome Centre.

Even if developing countries produce their own solutions for sustainable development, the reality is that new technologies in agriculture are most likely to come in the form of a tiny seed bought from a biotech company. The main problem, therefore, lies in providing such high-yield or resistant seeds to the countries that would benefit the most at a price that poor farmers can afford to pay. Sixty-two per cent of global research and development in biotechnology





is carried out by the private sector, with the USA being the main player and Europe taking a secondary role. Although countries such as China, Singapore, Brazil or South Africa are investing heavily into biological research, they still make only a marginal contribution. Nobody at the conference underestimated the importance of profit-making to persuade companies to invest into research, but clearly this capitalistic model exclusively benefits farmers in industrialized countries. The problem of poor investment by the public sector was taken up by Peter Hartmann, Director General of the International Institute for Tropical Medicine (IITA), who called for more public funding, as industry's ears are too often closed to the problems that haunt the developing world.

But it is not only important to fund the development of new technologies *per se*. Indeed, many speakers stressed that there need to be funds to support additional risk-assessment projects, ranging from toxicity to effects on biodiversity and gene flow. Furthermore, devising strategies to implement new technologies in developing countries requires additional expertise. And this is where the public sector clearly has an advantage, but one that it does not often embrace. Poul Nielson, the EU Commissioner for Development, stated that "politics runs behind money," and stressed the need for multilateral policies that take

into consideration the problems faced by developing countries. Moreover, the implementation of these policies should be through informed and democratic strategies and co-ordinated regional funding. The role of the EU, therefore, is to support the careful use of new technologies on the basis of the needs, autonomous nature and regional policies of developing countries. Nielson underlined that rules and decisions cannot, and in effect should not, be imposed by the developed world. It is the developing countries themselves that are expected to reach their own decisions, on the basis of their ethical and regional context.

Philippe Busquin, in his final speech, elaborated further on this topic, pinpointing the requirement to establish a political agenda for productive and independent research. He stressed that the EU has the task of sound implementation of new agricultural technologies, not only in Europe but also worldwide. Transparency with regard to policy making and funding distribution has a key role, and the EU sees its responsibility as being one of orientating European laboratories towards assessing the applications and risks of new technologies. As Emilia Müller, a member of the European Parliament, stated "Biotechnology is not the answer, it's a tool," and it must be combined with traditional agricultural techniques, policies, adequate investments, scientific

risk-assessment evaluations and proper management. Only in this way can new agricultural technologies function in a manner that will help developing countries and contribute significantly to tackling the increasing demand for food.

Committed policies, education, increased public funding and investments into risk assessment are all, therefore, required—all in all, a massive task that the EU is nevertheless willing to undertake. Both Busquin and Nielson clearly stated that the EU is standing by developing countries in their efforts to improve the quality of life of their people. In this regard, the EU and the USA must work together closely to ensure the success of large-scale programmes, but it was made clear that even if the USA is unwilling to participate, the EU should proceed. Overall, a new pattern seems to be emerging, which began when the EU went ahead to fulfil the Kyoto treaty to combat global warming without waiting for the USA. Indeed, the tensions between these two major powers has grown because of the increasing unwillingness of the USA to participate in international co-operation. As an indictment of the European disappointment with the current US administration, Nielson openly accused the USA of compromising such developments and leaving it to Europe to finish what they originally promoted together. Nielson stated that a balanced end to this debate would be to tell the USA "If you stop lying about us, we will stop telling the truth about you."

Indeed, the EU's emphasis on public funding and public structures for promoting sustainable development and agriculture is at odds with the predominantly capitalistic approach favoured by the USA. When asked whether this would mean that a form of agricultural socialism is required to make sustainable agriculture a reality, Timothy Reeves, former Director of the International Maize and Wheat Improvement Centre, answered that this is indeed socialism, but a win-win socialism. It requires a form of socialism in which all parties involved benefit—a tough challenge, Reeves said, but a challenge definitely worth rising to.

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